



Africa Research in Sustainable Intensification for the Next Generation

Sustainable Intensification of Key Farming Systems in the Sudan
and Guinea Savannas of West Africa

Book of Abstracts
Africa RISING West Africa project Phase 1 Legacy

December 2016



The Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) program comprises three research-for-development projects supported by the United States Agency for International Development as part of the U.S. government's Feed the Future initiative.

Through action research and development partnerships, Africa RISING will create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base.

The three regional projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads the program's monitoring, evaluation and impact assessment. <http://africa-rising.net/>



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This document was made possible with support from the American people delivered through the United States Agency for International Development (USAID) as part of the US Government's Feed the Future Initiative. The contents are the responsibility of the producing organization and do not necessarily reflect the opinion of USAID or the U.S. Government.

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Note

This book of abstracts has been produced as a working reference material for writeshop participants attending the Africa RISING West Africa Project phase 1 legacy workshop from 12 December – 13 December, 2016. The abstracts presented herein therefore provide an overview of peer reviewed publications being written by the project research team as a contribution to the scientific legacy of Africa RISING WA phase 1.

Section 1: Socio-economics of intensification

A Spatial Analysis of Land Cover Change and Rural Livelihoods: Evidence from Northern Ghana

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Abstract:

Using satellite imagery of northern Ghana around 1994 and 2014 and household survey data in 2014, we examine the relationship between land cover change and current productivity and harvest value. Data from georeferenced household surveys, remote sensing, and other secondary sources reveal the relationship between landscape-level transformations and household-level outcomes. Areas currently cultivated but covered by vegetation in 1994 show higher agricultural production and productivity than those previously bare. Thus expansion of cropland into degraded areas with poor soil fertility may not yield positive gains, threatening the sustainability of agricultural production upon which millions of poor smallholders rely. This in turn calls for effective conservation practices to restore the soil nutrient content and improve rural livelihoods.

Keywords: Land cover change, agricultural productivity, spatial regression, spectral analysis.

Inherent motivations and impediments to the adoption of innovative practices and technologies by farmers: An empirical analysis from northern Ghana

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Abstract

Previous adoption studies have been focusing on socio-economic and demographic factors influencing technology adoption but neglect socio-psychological factors. This study used data collected from a household survey in the three regions of northern Ghana to examine the inherent motivations and impediments to the adoption of innovative practices and technologies by farmers. The analysis utilized basic statistics and multivariate techniques (i) to identify inherent motivations and impediments to the adoption of sustainable intensification practices, and (ii) to explore how these motivations relate to the perceived impediments to the adoption of the practices. The analysis resulted in three motivational dimensions driving adoption for sustainable intensification: (1) eco-satisfaction (main variables: personal rewarding, ease of use and access to food) (2) eco-diversity related to crop diversity, less fertilizer input and improved nutrition and (3) eco-efficiency associated with environmental protection, productivity and income. Farmers identified uncertainty, lack of social support, and resource constraints as main factors of impediments to adoption. Furthermore, the study found significant correlations between motivations and impediments. Notably, there was significant correlation between eco-satisfaction and lack of social support as a perceived impediment to the adoption. Moreover, a significant correlation was found between eco-diversity and all the impediments. The study suggests that researchers and technology implementers should closely work with farmers to develop strategies that tap into farmers' inherent motivations during program design and outreach activities. The use of different extension strategies (e.g. farmer field school, innovation platforms, etc.) can help in this regard.

Keywords: Motivation; Impediment, Sustainable Intensification Practices; Adoption; Technology; Northern Ghana.

Transhumant practices and its effects on natural resource management in the Sudano-Sahelian Zone of Mali

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Abstract

Forage and water scarcity in the Sahelian zone of West Africa, especially in the dry season, has led to increased livestock movement into Sudano-Guinean zone. This increased movement by transhumant herders into this area has resulted in increasing competition over natural resources and may lead to natural resource degradation. Despite the strong presence of transhumant herds in the Sudano-Sahelian zone of Mali in the past 30 years, there has been limited research on the practice of transhumance in that zone compared to several studies in the Sahelian zone. In this paper, we present how various actors perceived impact of transhumant practices on natural resource management. The findings discussed in this paper are based on a series of surveys and focus group discussions conducted in two districts in southern region of Mali. Results from the study showed that more than 75% of all categories of respondents in both study sites perceived a decrease in availability of forage resources and water as a result of increased number of transhumant herders in their communities. Furthermore, a greater proportion of farmers and settled pastoralists in both study sites responded that there has been a decline in species richness of the vegetation due to overexploitation by the transhumant herders. In contrast, more than 50% of transhumant herders did not see any change in natural vegetation due to their presence. They argued that the observed decline in species richness of the vegetation is due to climate change. Education level, location and socio-professional categories tended to be the key factors influencing respondent's perception of impact of transhumant practices on natural resources management. As the perceived impact of transhumant practices depends on socio-profession groups, it is necessary to engage all the actors on how to effectively manage the presence of transhumant herders to promote sustainable use of natural resources in Sudano-Sahelian zone of Mali.

Keywords: Transhumance, perception, natural resources, farmer-herder relation, Mali

Model results versus farmer realities. Operationalizing diversity within and among smallholder farming systems for a nuanced impact assessment

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Abstract

Agricultural production in Northern Ghana is dominated by smallholder farming systems characterized by low inputs and low outputs, declining soil fertility, large yield gaps and limited adoption of agricultural technologies. There is urgent need to identify and discuss alternative farm designs that are more productive, yet more sustainable. Farming systems are diverse in their features, constraints and opportunities and so are their possible intensification pathways. We assessed the impact of technology packages that were proposed to smallholder farmers in selected communities between 2013 and 2016 in the Upper East, Upper West and Northern Region of Ghana. We then used a locally validated framework to categorise farming systems diversity that considers both, a horizontal (between households) and vertical (within households) dimension of diversity. Farm households were classified along a gradient of resource endowment. We selected one representative farm per type and per region to assess and compare their socio-economic and environmental performance (profit, labour, soil organic matter) using the whole-farm model Farm DESIGN. We then used Farm DESIGN to assess the potential impact of five project proposed technology packages and to explore promising alternative farm configurations. We validated the model results with farmers by scrutinizing model assumptions, by discussing alternative cropping patterns and trade-offs. We evaluated technologies with different household members using a weighted scoring technique, juxtaposing model results with farmer perceptions, experiences and expectations. Our model results indicate that the tested technologies would have the greatest relative positive impact on low resource endowed farms and that large differences prevail among farm types concerning the potential impact of technologies on their socio-economic and environmental performance. The farmers' feedback established that the most profitable alternative farm configurations were correctly determined by the model but would be hard to attain in reality, particularly for members of low and medium resource endowed households, due to high initial investment costs coupled with a generally poor access to financial services for farmers. Within households, women were more positive about the AR packages since men heavily penalized extra cost and labour, translating into a greater congruence of model results with the male evaluation. We further recommend to differentiate between technical (technology i.e. purchased tools and inputs) and managerial (techniques e.g. row planting) components within an agricultural 'package'. We conclude that operationalizing inter and intra-household diversity is a fundamental step to identifying sensible solutions for the challenges of complex and diverse local smallholder farming systems in Northern Ghana.

Keywords: Whole-farm model Farm DESIGN, Ghana, typologies, intra and inter household diversity, technology adoption

Are farmers searching for an African green revolution? Exploring the solution space for agricultural intensification in southern Mali

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Abstract

Development actors, including the African Union, the Alliance for a Green Revolution in Africa, and bilateral donors, promote sustainable intensification of agriculture as a way to feed growing world population and reduce rural poverty. A broader view of smallholder agriculture in the context of rural livelihoods suggests that technological solutions alone are unlikely to meet these goals. Options for rural households should fit within the households' socio-ecological niches and respond to their priorities in order for them to be successful. Analysis of the solution space for agricultural intensification in a high potential area of Southern Mali shows that intensification can lift farm households out of extreme poverty and guarantee their food self-sufficiency. Cropland expansion combined with the good yields seen in on-station experiments can nearly eliminate extreme poverty. However, even with good yields, dryland agriculture is less profitable than alternatives including meat production with small ruminants or sales of milk from cows. Off-farm income opportunities like gold mining remain the most profitable options for many households. Given the relatively low profits possible from dryland agriculture, a rethinking of the role of agricultural research in development is needed in order to align innovations with farmer priorities and meet development goals.

Economic analysis of alternative systems for sorghum production in Southern Mali

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Abstract

This article aims to evaluate sorghum grain yields, cash income as well as risk-efficient choice associated to cropping treatments of sorghum under the Africa RISING project in Southern Mali. The analysis used the survey data related to on-farm trials covering the seasons 2014 and 2015. Four treatments have been experimented for sorghum including traditional system as a control treatment, treatment with only manure, treatment with mineral fertilizer, and treatment with manure and mineral fertilizer. Stochastic dominance analysis was used to evaluate the cumulative distributions of grain yields and cash income associated with each treatment. The results showed that the control treatment for sorghum is dominated by the manure and fertilizer treatments. The manure and mineral fertilizer treatment has higher yields and net returns compared to the three other cropping treatments. The control treatment has a 50% chance of generating grain yields up to 850 kg/ha, while the manure treatment, mineral fertilizer treatment, and manure and mineral fertilizer treatment have the same probability of generating respectively 1,050 kg/ha, 1,275 kg/ha, and 1500 kg/ha. The average net returns were estimated to FCFA 60,811 (USD 122) for manure and mineral fertilizer treatment, FCFA 43,598 (USD 87) for treatment with only mineral fertilizer, and FCFA 41,787 (USD 84) for treatment with only manure. The cumulative distribution of manure and mineral fertilizer treatment was to the right of the remaining cropping treatments, indicating that manure and mineral fertilizer treatment provides higher returns to smallholder farmers than the alternative treatments for a given risk level. Risk-averse farmers will prefer cropping treatment applying manure and mineral fertilizer if they can afford manure and chemical fertilization.

Exploring gender differentials in adoption of sustainable intensification practices in northern Ghana

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Abstract

This study aims to assess the gender differentials in adoption of sustainable intensification practices (SIPs) in northern Ghana based on plot level data. The analysis utilizes the multinomial endogenous treatment effects model, which allows the assessment of adoption and impact of sustainable intensification practices in a joint framework. We considered three sustainable intensification practices, namely: improved seeds, cropping system strategies, and the combined practices. The findings show that female farmers in female-headed households are less likely to adopt improved maize and cropping system strategies. Conversely, females in male-headed households are less likely to adopt cropping system strategies. The results also show that the adoption depends on household labor, education, and other factors. Furthermore, the adoption of improved maize only and the combined practices resulted in higher yields and net income compared to cropping systems strategies. The findings suggest the need for gender differences to be taken into account when designing and disseminating technologies. In addition, the resources of farmers should also be taken into consideration during dissemination as improved maize only demand a greater amount of inorganic fertilizer, which is often expensive to most rural farmers.

Keywords: Gender; sustainable intensification practices; multinomial endogenous treatment effects, northern Ghana

Section 2A: Intensifying crop production

Effects of cowpea growth types as an intercrop on grain yield and profitability of hybrid maize production in northern Ghana

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Abstract

Sole maize cropping system introduced as a result of the hybrid maize production is a challenge in terms of intercropping to small scale farmers in Northern Ghana who normally intercrop grain cowpea with open pollinated maize varieties.

To address these concerns, studies were conducted at Nyankpala and Dipali both IITA interventions communities in the Savanna region of Ghana in 2014 and 2015 farming seasons. Two cowpea growth types, erect and spreading were intercropped with hybrid maize to assess the influence of these intercrops on the physiological behavior of the hybrid maize and their impact on the productivity of the system.

Experiments were carried out both on-station and farmers' fields. The on-station experiment was a split plot arranged in RCBD with four replications. The main plot factor was cowpea growth type, erect cowpea (Songotra), spreading cowpea (Sanzi) and no cowpea (sole maize). The sub plot factor was maize varieties, which were hybrid maize varieties. Pan53, Etubi, Mamaba and Obatampa (OPV). The on-farm experiment was RCBD experiment in ten farmers field, each represented a replicate and the best four were selected for analysis.

Results at on-station showed that grain yield of sole maize (No cowpea) plot produced significantly higher grain yield than maize intercropped with cowpea plots. Maize yield in the intercropped treatments were similar. In the subplot treatments, Pan 53 produced significantly higher yield than all the other varieties. The Obatampa variety produced significantly higher yield than Etubi and Mamaba varieties both of which produced similar grain yields.

Results showed that Pan 53 produced significantly higher grain yield either sole or intercropped than all the varietal effects. Grain yield of the other three sole maize crops were not significantly different from one another. Maize grain yield in all the intercrops were significantly lower than in their sole crops, irrespective of the cowpea growth type.

Grain yield of the sole cowpea was significantly higher than in the intercrops irrespective of the growth type. Indeed, intercropping with maize reduced grain yield of cowpea between 70% and 100%. The greatest total net returns (NR) of maize and cowpea were from the intercropped plots. Pan 53 intercropped with spreading cowpea recorded highest net return.

The results of Benefit Cost Ratio (BCR) of cowpea intercropped with maize showed significantly higher as compared to their respective soles. However, sole Pan 53 and its intercrops were not significant.

In conclusion, all the hybrid maize can do well with the mixture of the two growth types of cowpea. Obatampa as an OPV is adapted to the growing conditions in the lowland tropics and could withstand the competitive effects of intercropping to give good returns. With the Pannar variety both the sole and the mixture showed no significant differences in grain yields.

Corralling, planting density and n fertilizer rate effect on soil, weed and maize yield.

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Abstract

The study determined the interaction effect of stocking density of sheep and goat corralling (SDSG), maize plant density (MPD) and N fertilizer rate (NFR) on soil, weed dynamics and maize (*Zea mays L.*) yield in a smallholder maize-livestock farming systems in Northern Ghana. A split-split plot design with 8 household farms as replicates was used to study the effect of three stocking density of sheep and goat corralling (SDSG; 0, 70 and 140 heads ha⁻¹), three maize plant density (MPD; 66 667, 100 000 and 133 333 plants ha⁻¹) and three nitrogen fertilizer rate (NFR; 0-40-40, 60-40-40 and 90-40-40 NPK kg ha⁻¹). The SDSG increased soil chemical, biological and weed dynamics compared to the control in both 2014 and 2015 cropping seasons. The SDSGxMPD and SDSGxNFR interaction increased maize grain yield by 92%. Maize-livestock farmers with low resource endowment can corral sheep and goat without mineral fertilizer, those with low flock size can corral at 70 heads ha⁻¹ with 90 kg ha⁻¹ N fertilizer, and those with large flock size can also corral at 140 heads ha⁻¹ with 60 kg ha⁻¹ N mineral for better grain yield. Maize-livestock farmers may also corral sheep and goat at 70 heads ha⁻¹ with maize plant density at 50% higher than the recommended density for better grain yield and weed management.

Keywords: Kraaling, Maize-livestock, Soil characteristics, Yield

Optimization of maize-vegetable intercrops in Northern, Upper West and Upper East Regions of Ghana

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Abstract

Intercropping is an important practice in subsistence and food production farming systems in many developing countries. In the Guinea savanna of Northern Ghana, vegetable-maize intercropping with okra, tomato, hot pepper, African eggplant, roselle and other vegetables is widely practiced during the humid season. Although this system is dominant, little is known regarding the optimal population densities and spatial arrangements for intercropped vegetables. Our objective was to determine the profitability of maize-vegetable intercropping as well as the biological yields resulting from various spatial arrangements and planting densities of intercrops. Trials were conducted during the rainy season from May to October of 2014 and 2015 in the Northern, Upper West and Upper East regions of Ghana. Each trial had eight treatments, including two pure stand options for each crop and four different vegetable-maize intercrops. The field layout was a randomized complete block design with three to four replications. Each farmer was assumed as a replication. Data collection included biological fruit or grain yields and estimation of land equivalent ratios (LER). LER values varied from one region to another and sometimes over years. Recommendations were made for stable spatial arrangements and planting densities that can be profitable to farmers.

Keywords: Maize-vegetable intercrops, sole crop, land equivalent ratios, productivity

Integrated soil fertility management effect on grain and fodder yields and soil chemical and physical properties in soybean-maize rotation in northern Savanna

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Abstract

Declining maize (*Zea mays* L.) yields caused by factors, such as inherently poor soils, continuous cropping of cereal after cereal, high cost and unavailability of chemical fertilizers, continuous crop-residue removal, and soil erosion and runoff, have all contributed to low soil fertility and reduced maize yields in northern Ghana. To address this negative trend, a four-year field trial was conducted at Bonia in the Kassena-Nankana Municipal in the Upper East Region of Ghana. The treatments comprised Soybean with no soil amendment; soybean with inoculant only; soybean with inoculant plus PK (60 kg P₂O₅/ha and 30 kg K₂O; soybean with inoculant + fertisol; soybean + inoculant + PK + fertisol and soybean + recommended fertiliser rate (25-60-30 as N P₂O₅ and K₂O) and the control maize after maize. The test crops were for soybean 'Jenguma' a non-shattering variety and for maize CSIR-Omankwa, a drought tolerant, *striga hermonthica* resistant and quality protein maize. A randomized complete block design with four replications was used. Soybean and maize recorded superior plant growth, development and yield components such as days to 50% bloom, plant height, number of plants or cobs at harvest, 100-grain weight and harvest indices as evidenced in the consistently greater grain and biomass for soybeans that were inoculated with addition of soil amendments such as fertisoil and P and K and were rotated with maize in the preceding years. This suggests that, in addition to the inoculation of soybean it is important to add a soil amendment; such as fertisoil, or PK, or PK and recommended NPK so as to obtain good maize grain and straw yields.

Keywords: Soybean, maize, inoculant, fertisoil, NPK, rotation, grain and biomass yields

Improved rice variety responses to nitrogen rate in Northern Ghana

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Abstract

Rice (*Oryza sativa* L.) is an important grain crop worldwide and a primary food source for many people. High yielding seed is a major determinant of agronomic, economic and productivity benefits accruing from other inputs. The use of quality improved rice seed and adequate N application for enhanced agronomic and economic benefits of paddy yields is key in the study area. It is against this background that on-farm mother-baby trials were carried out to assess the agronomic and economic benefits of applying different N rates to Gbewaa, an improved rice variety. The effects of five nitrogen levels (i.e. 0, 30, 60, 90 and 120 kg/ha) on paddy yield and yield components on a local (check) and Gbewaa rice varieties were studied in three communities in Upper East Region of Ghana. There were significant differences between the varieties for grain yield in each of the 3 sites. Grain yield of each rice variety significantly ($p \leq 5\%$) increased with increasing levels of N above the recommended rate of 60 kgN/ha up to 90 kg N/ha beyond which there were no further significant increases. Economic analysis showed the improved variety also recording consistently higher net benefit and benefit-cost ratio across the three locations.

Key words: Rice, nitrogen rates, grain yield and variety

Livestock Corralling Density Effect on Soil Quality Index in Northern Ghana

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Abstract

A 2-year study was conducted to evaluate the stocking density of sheep and goat (SDSG) corralling (0, 70 and 140 heads ha⁻¹) on soil quality index in Northern Ghana. A RCBD design with eight household farms as replicates was used. Sheep and goat weighing 27±2.0 and 24±1.5 kg respectively were corralled on the fields from 19: 00 to 06: 00 GMT hours during the 2014 and 2015 cropping season. Soil total nitrogen, carbon/ nitrogen ratio, porosity, moisture, microbial biomass carbon and microbial quotient were selected as minimum data set for soil quality index (SQI) using principal component analysis and multivariate correlation analysis. The SDSG corralling improved chemical and biological soil quality sub-indices, but decreased physical sub-quality index due to the trampling effect of the sheep and goat. The SQI rating for sheep and goat corralling was 1.1 compared to the control which had 0.9. Increasing the SDSG corralling from 70 to 140 heads ha⁻¹ had no effect on SQI rating. The results suggest that crop-livestock farmers with small ruminants can corral 70 heads ha⁻¹ sheep and goat as a means of soil fertility amendment with minimum effect on soil physical properties.

Keywords: Small ruminants, Stocking density, Soil quality, Soil properties

Intensification of cool dry season vegetable production in Africa rising project intervention zones of South Mali

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Abstract

Vegetables are affordable sources of income and nutrients for poor resource people in developing countries. Dry season vegetable production contributes to crop intensification and sustainability through all year round production. In Mali, dry season vegetable production was initiated under Africa rising project for the purpose of production intensification in the district of Bougouni and Koutiala in North Guinea and Sudan savannah respectively. Three vegetable crops (okra, African eggplant and tomato) were involved in on farm testing in 2014 and 2015. Two improved varieties were compared to the most performing varieties for each of the three vegetable crop species. Each treatment was a combination of two types of soil organic fertilizer applications (20t/ha of compost, farmers' practices (10t/ha manure). The field layout was a factorial of six treatments of 3 varieties x 2 crop management practices randomized complete block design with five to 12 replications per site. Each farmer was assumed as a replication. Data collection included biological fruit yields. Wilkinson stability analysis and coefficients were used to determine the stability of the technologies over two years and two sites. As results of Wilkinson stability analysis, although the local okra check variety was not as much responsive to compost (low yield) as the top variety, it was the most stable genetic material over time and space. However, the improved okra variety B and African eggplant variety L10 were highly responsive to high performing environments such as Koutiala. In general, vegetable varieties were not very responsive to crop management practices across sites and years. Improved varieties although unstable across sites and years, were highly responsive to favorable environments and could be recommended for dissemination under intensification.

Keywords: intensification, okra, African eggplant, tomato, fruit yield, stability analysis, environment.

Section 2B: Intensifying livestock production

Effects of ensiling cassava peels on some fermentation characteristics and on growth performance of sheep on-farm

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Abstract

A supplementary feeding trial was conducted to determine the effect of ensiling cassava peels on some fermentation characteristics and on the growth performance of sheep. Fresh cassava peels were either ensiled in large bag silos or were sun-dried and used to formulate a two diets (cassava peels: whole cotton seed 3:1) that were fed as a supplementary diet to sheep for 70 d. Peels were also ensiled in mini silos and opened on day 1, 3, 10, 15 and 45 for measurement of pH and for enumeration lactic acid bacteria, yeasts and moulds. Nine communal pens containing > 7 sheep were randomly allocated to 3 dietary treatments; Control (no supplementation), ensiled cassava peel-based diet or dried cassava peel-based diet. A total Forty-five Djallonké sheep (11.91 kg; SD = 2.6) were used in the study. Data was analyzed by the MIXED model procedure of SAS. Ensiling reduced the pH from 5.65 in the fresh peel to 4.15 after 45 days of ensiling compared 6.15 in the dry peels. Ensiling also increased the CP concentration from 45±0.44 g/kg DM in the fresh peel to 52±0.88 g/kg DM in the ensiled peel compared to 46±0.48 g/kg DM to in the dried peel. The concentration NDF was reduced by 19% in the ensiled peel compared to 7% in the dried peel. Populations of moulds were also greater ($P = 0.011$) in the ensiled peels than dry peels but the yeasts populations did not differ ($P = 0.474$). The daily rate of body weight gain was higher ($P = 0.031$) for sheep fed the ensiled peel than for those fed the dried peel and those that did not receive any supplementary diet. Total body weight gain was also greater ($P = 0.028$) for sheep fed the diet containing the ensiled compared to the dried cassava peel or the Control. Ensiling improved the fermentation characteristics of cassava peels and improved the growth performance of sheep compared to sheep offered the dried peel or offered no supplementary feed under small-holder production systems.

Key words: cassava peels, drying, ensiling, average daily gain, sheep

Growth performance and survivability of guinea fowls (*numida meleagris*) production through supply of young guinea fowls and eggs to farmers in Nadowli district of Upper West Region

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Abstract

The traditional method of brooding and rearing Guinea fowls poses a threat to the sustainability of Guinea fowl production in Ghana. An on-farm experiment was conducted in five communities (Goli, Goriyiri, Papu, Gyilli and Nato-Douri) in the Nadowli District of the Upper West Region of Ghana to determine the growth performance and survivability of guinea fowls through the supply of young guinea fowls and eggs towards the sustainability of guinea fowl production. Two hundred 9 weeks old and Two hundred 12 weeks old young guinea fowls were randomly assigned to 10 farmers each in Goli and Goriyiri communities. Two hundred and thirty-three guinea keets were hatched out of seven hundred and fifty eggs supplied to farmers representing 31.1% hatchability. One hundred and twenty-seven keets survived after the natural brooding representing 54.5% survivability and was used as the control treatment. The semi-intensive system of production was used by the farmers. The control birds recorded lower initial live-weight, daily live-weight and final live-weight gain than the 9 and 12 weeks old birds. The control birds recorded higher mortality (32%) than the 9 (25%) and 12 (24%) weeks old birds. Based on the results of this study, it can be concluded that the birds raised under artificial brooding system performed better than those raised under natural brooding system. Also, it is preferable and economical to brood keets artificially up to 9 weeks of age before rearing under semi-intensive system.

Direct fed microbial effects on laying performance and health response of indigenous Ghanaian guinea fowls (*Numida meleagris*).

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Abstract

Indigenous guinea fowls (*Numida Meleagris*) were fed Direct-Fed Microbial (DFM) in Northern Ghana. A total of 144 nine (9) week old guinea keets were randomly allocated to 4 frequency regime which include: control, daily, 3 consecutive days per week (CDW) and 7-days repeated every other week (DREOW) of DFM at 1.5ml/L through water for 30 weeks in a Completely Randomized Design with 3 replicates per treatment. Feed intake, body weight gain, feed conversion ratio, egg weight, yolk weight, egg albumen weight, shell weight, shell thickness, mortality, hematological and serum biochemical parameters were recorded. Birds on daily DFM treatment consumed less feed ($P=0.007$) with an increase weight gain ($P=0.009$). Hen-day egg production, egg shell thickness and weight, blood albumin weight and height and yolk weight and heights were not different between treatments. Egg weights significantly increased ($P<0.0001$) with the supplementation of DFM in water. Serum albumin was significantly higher ($P=0.024$) in daily DFM treatment while serum LDL cholesterol concentration reduced ($P=0.017$) and total blood protein increased ($P=0.092$) by the DFM supplementation through water compared to the control. The results showed that supplementing DFM in water daily at 1.5ml/litre of water resulted in improved health and performance of laying guinea fowls.

Keywords: Keets, DFM, body weight, weight gain, blood parameters.

Effect of concentrate feed supplementation plus healthcare and season on dry matter and nitrogen flow and growth performance of sheep in smallholder production system

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Abstract

Inappropriate feed supplementation of animals in smallholder system, decreasing quality of forage at pasture across seasons and poor healthcare are major constraints to productivity. This study was conducted to estimate the effect of concentrate supplementation plus healthcare and season on dry matter and nitrogen flow and growth performance of sheep. This was done as a randomized complete block design. A total of 36 smallholder sheep farmers' pens with a total of 819 animals were randomly selected for the study. The animals in each pen were randomly assigned to one of 2 management regimes. In the first regime, sheep were grazed on pasture from 09:00 to 17:50 h and offered crop residues and/or agro-industrial by-product (75 g/d DM) upon return (Control). In the second regime, sheep were treated similarly as in the control and given additional combined package of concentrate feed (180 g/d DM) plus veterinary recommended healthcare in the area. Dry matter inflow (intake), faecal output (DM) and partial nitrogen balance were estimated across seasons. The weight gain of animals was also determined. The data was collected in each season [early dry (November-January 2013), late dry (February-April 2014), early wet (May-July 2014) and main wet season (August-October 2014)]. Animals on supplementation DM inflow (608 g/d DM) was higher ($P<0.05$) than control (515 g/d DM). Season significantly ($P<0.05$) affected DM intake. The highest feed intake (679 g/d DM) was observed during early wet season and lowest (397 g/d DM) in main wet season. Faecal voiding (DM) of animals was not affected ($P>0.05$) by concentrate supplementation plus healthcare. Season however, affected ($P<0.05$) faecal output of animals. Nitrogen inflow was affected ($P<0.05$) by concentrate supplementation (10.50 versus 8.09 g/d DM for concentrate supplemented and control). Season also significantly affected nitrogen inflow. Faecal nitrogen content in both treatments was similar but differed across seasons. Highest N output (6.01 g/d DM) occurred in early wet season and lowest (3.8 g/d DM) late dry season. Concentrate supplementation positively affected weight gain. Average daily gain (ADG) of 34 g/d observed in animals on concentrate supplementation was higher ($P<0.05$) than 18 g/d in control group. Season did not ($P>0.05$) affect ADG of animals. Supplementation is most needed during late dry season to maintain or improve the productive performance of animals. High quality faecal droppings could be collected in early dry and early wet seasons for improving poor soils.

Key words: smallholder farmers, feed resources, season, supplementation, nitrogen flow, sheep

Feed intake and growth performance of sheep fed peanut haulm conserved as hay or silage

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Abstract

Drying and ensiling are the major methods of conserving forages for feeding ruminants, however, peanut haulms are commonly harvested, field-cured and stored as hay in the rainy season which may lead to leaf losses and nutrient leaching thereby reducing the nutritional quality of the hay. Ensiling may reduce these losses but intake of silage can be lower than hay. This study investigated the effects of conserving peanut haulm as hay or silage on growth performance of sheep. Peanut was harvested at the full-pod stage of maturity and was either ensiled or dried for 171 d. The resultant forages were used to formulate two total mixed rations that were fed to twenty intact West African Dwarf ram-lambs (14.8 ± 2.9 kg (mean \pm SD)). Sheep were randomly assigned to each dietary treatment in a completely randomized design and data was analyzed by the MIXED procedure of SAS. The water-soluble carbohydrate concentration of the fresh haulm was 21.4 g/kg DM and the pH of 5.4 of the silage was higher than the threshold pH of 3.75-4.0 required to prevent a surge in spoilage microorganisms that causes reduction in silage quality. Increased concentrations of Ammonia-N and butyric acid indicated a proteolytic pattern of fermentation. Dry matter intake of the silage-based diet was depressed ($P=0.069$) by 117.9 g/d compared to the hay-based diet. Sheep fed the silage-based diet compared to the hay-based diet similarly had slower rates ($P=0.012$) of daily body weight gain (38.8 vs. 81.8 g/d) and poorer ($P=0.012$) efficiency of utilization of feed for gain. Proteolytic fermentation as evidenced by the population of yeasts and concentrations of butyric acid and ammonia N, may account for the poorer intake and growth performance of sheep fed the silage-based diet. Efficiency of utilization of feed for gain was reduced ($P=0.053$) by ensiling compared to drying the haulm and the sheep fed the hay diet grew more than twice (83 vs. 39 g/d) as fast as those fed the silage diet. The quality differences between hay and silage in the present study could account for the difference in ADG and feed efficiency. This study suggests that intake of poor quality peanut silage diets may decrease DM intake and growth performance of sheep compared intake of hay diets.

Key words: Growth performance, hay, peanut haulm, silage, sheep

Direct-fed microbial diet effects on Guinea fowl (*Numida meleagris*): Growth performance and health responses in northern Ghana

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Abstract

The present study was conducted to investigate the effect of intermittent use of direct-fed microbial (DFM-“RE3[®]”) on growth performance and health status of indigenous guinea fowls in northern Ghana. Four (4) direct fed microbial frequency regime which include: control, daily, 3 consecutive days per week (3CDW) and 7-days repeated every other week (7DREOW) of direct fed microbial at 1.5ml/L through water were randomly assigned to 180 day old guinea keets from day1 to 56days. Feed intake, body weight gain and blood hematological and serum biochemical properties were recorded. The treatments had no effects ($P>0.05$) on the hematological and serum biochemical properties recorded. Birds on DFM treatments appeared to consume less feed (range: 1584-1824g/day) compared to the control (1870g/day/head). Birds on DFM treatments daily and 3CDW gained more ($P<0.05$) weight (334-394g/d) compared to the control (306.1g/head) with keets on daily DFM supplementation recording the lowest ($P<0.05$) feed conversion ratio. The total blood protein, globulin, lipids, albumin concentrations and cholesterol concentrations were not affected ($P>0.05$) by DFM supplementation. Supplementing birds with 1.5ml of RE3[®]/litre of water daily can improve body weight. Further research on immune competence from the spleen, thymus and bursa fibrosis for evidence of increased immune competence in probiotic administered birds is recommended.

Key words: Keets, DFM, body weight, weight gain, blood parameters

Rice bran as a feed resource in crop-livestock systems: impact on growth performance, body condition scores (BCS), girth width, carcass traits and blood profile of indigenous pigs in the upper east region of Ghana

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Abstract

A research work involving Ashanti Dwarf pigs (ADPs) were conducted as part of the Africa RISING intervention programmes aimed at improving the livelihood of the people of the Upper East Region of Ghana and to demonstrate to the indigenous pig farmers the feasibility of keeping pig intensively. Semi-structured questionnaires were administered to 40 farmers selected randomly from the study areas (Nyangua, Bonia, Tekuru and Gia). Data generated included socio-economic characteristics of respondents and pig production parameters. Proximate composition, ADF, NDF, microbial, fungi and insect pest status of the feed ingredients and the compounded diets were determined. A total of thirty-two grower ADPs aged 3 – 4 months with an average initial weight of 8.50 ± 0.19 kg were kept with 16 different farmers. The pigs were allotted to four treatments and fed *ad-libitum*, with iso-nitrogenous diets containing 0, 300, 400 and 500g/kg RB. Feed intake, weight gain and feed conversion ratio were determined at two weeks interval and at the end of the feeding trial. Body condition scores, girth width, haematological and serum biochemical assay were determined. Carcass characteristics were also determined after slaughter. Dawadawa pulp flour, pito mash, groundnut skin meal, cut grasses, mill waste, kitchen wastes and rice bran were found to be the main feed ingredients available in those communities. The pig producers were confronted with major production constraints such as disease incidence, high cost of feeds, high cost of conventional drugs and poor housing. *Tribolium* species, with both live and dead insects as well as the larvae and the adults were present. The microbes identified were *E. coli*, *Salmonella typhi*, yeast and mould (*Aspergillus niger* and *A. versicolor*). There were significant ($P < 0.05$) differences in mean daily feed intake where no RB inclusion diet gave significantly lower values than RB-based diets (300, 400 and 500g/kg). There were no significant ($P > 0.05$) differences in mean daily weight gain and feed conversion ratio (FCR) values for the four dietary treatments. There was a linear decrease in feed cost as the level of RB increased in the diet, and the cost of gain followed a similar trend. There were similar body condition scores and girth width measurements for all pigs under the different diets at the end of the trial. The haematological and serum biochemical studies did not ($P > 0.05$) indicate any dietary influence and the carcass characteristics were similar ($P > 0.05$). It was concluded that indigenous pig farmers can incorporate RB into their diets for the ADPs up to 500g/kg without any adverse effect on growth performance, body condition scores, carcass traits, haematological and serum biochemical characteristics.

Section 3: Land, soil and management

Water balance dynamics in agricultural systems of Northern Ghana: Interactions between farm-level and landscape fluxes in the face of climate change

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Abstract

Water balance dynamics at the farm level were investigated using real-time in-situ data collected with automated data loggers (2012-2014) while long-term historical hydrological and climatic data (1970-2014) were used with the Water World model to ascertain the impact of climatic change on agro-ecosystems in Northern Ghana. On-farm seasonal water balance estimates within a maize stand revealed that with the 716 mm of rainfall received in the season the ET was the predominant factor accounting for about 78% of the fluxes. Runoff levels were not significant for plots where farmers had conducted soil and water conservation measures and these accounted for 30% runoff levels compared to the control treatments. From a bioclimatic standpoint, study results indicate a steady increase in temperature and a projected increase in rainfall over the next 40 years to the 2050s. Increment in rainfall amount could be desirable considering the recurrent dry spells in the Northern parts of Ghana. However, the shorter term impacts, particularly changes in the frequency and severity of storm events remains uncertain since increased amounts over short durations may translate into regional extreme events in an area that is already prone to flooding. Managing variability in terms of water storage solutions that complement soil and water conservation measures will help farmers with better coping mechanisms and adaptation to climate change, particularly among the poor resource farmers in these vulnerable landscapes.

Key words: Water balance, agricultural systems, scale interactions, adaptation, climate change

A watershed approach to managing rainfed agriculture in the semi-arid region of southern Mali: Integrated research on water and land use

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Abstract

Soil and Water Conservation (SWC) practices like that of shallow wells and contour bunding were commonly practiced in the semi-arid region of southern Mali since the 1970s. The practices were meant to improve water availability and hence increase crop yield, reduce farm water runoff and gully formation. Despite the efforts made, the region is still faced with water scarcity and soil erosion that constrained the agricultural productivity and greater household income. Previous SWC efforts lacked sufficient data record to show potential benefits for wider application. In this paper a watershed approach to managing rainfed agriculture is presented. The approach included community participation in establishing and monitoring new sets of hydrometeorological monitoring stations and field experiments. Impacts of SWC practices on water runoff and soil moisture dynamics were studied.

In addition the recharging capacities of community managed shallow wells were evaluated on water level variations in different seasons. Results showed a significant reduction in runoff (p value 0.018) for farm fields treated with SWC practices. Runoff rates vary from 24 to 26 % and 39 to 43 %, in farm fields with and without SWC practices respectively. With three different events of rainfall, higher magnitudes of soil moisture recharging shallow aquifer were observed in the mid rainy season (33 %) and end rainy season (85 %) for farm fields treated with SWC practices. This recharge is necessary to improve the agricultural productivity and household income of rural Malians and it is helpful for the survival of trees during the dry and hot season. Further analysis of 254 community managed shallow wells revealed a non-significant water level variation (p value 0.996 and 0.707 in dry and rainy seasons respectively).

Water can be accessed at a maximum depth of 12.5 m in 84 % of wells (dry season) and at 8 m in 76 % of wells (rainy season). Lack of appropriate water lifting services partly attributed to the problem of water scarcity. The other factor could be lack of hydrological data record to study and design appropriate water storage system. The aridity and the low potential for surface water storage from runoff, suggest that subsurface water management may be a viable option through integrated watershed management programs. In this case strong institutional support is required at all levels. Presently there is a big interest by the national agricultural research institute of Mali, *Institute Economy Rurale (IER)*, and a local NGO *Association Malienne d'Eveil au Développement Durable (AMEDD)* to implement watershed programs. The important role of *IER* in

applied and adaptive research and *AMEDD* in providing extension services to local communities was found to be vital to implement watershed programs in Mali.

Key-words: Rainfed agriculture. Shallow wells. Contour bunding. Watershed management. Participatory approach. Southern Mali.

Soil and Water Management Techniques to Improve Soil Moisture for Maize, Cowpea and Soybean Production in Northern Ghana

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Abstract

Soil and Water Conservation (SWC) measures are interventions put in place to limit soil loss and sustain soil moisture in areas where there is the risk of losing the valuable topsoil and inadequate moisture. In 2014 rainy season, on-station and on-farm trials were carried out in Northern Region of Ghana to assess the effect of Contour Farming (CF), Half Moon (HM), Contour Ridges (CR) and Flat Bed (FB) yields of Maize, Cowpea and Soybean and on soil moisture retention at the on-station only. Results revealed significant effect of SWC methods on soil moisture content for maize, cowpea and soybean trials. The highest soil moisture was retained in the CF followed in decreasing order by CR, HM and the FB. At the on-station trial, significant effect of SWC measures was observed for maize and soybean grain yields. The on-farm trial showed significant effect of SWC measures on maize, cowpea and soybean grain yields. Considering the higher soil moisture retention and yield under CF, it is recommended as the best option among the studied methods for SWC in Northern Region of Ghana.

Keywords: Soil and water conservation, contour farming, half-moon maize cowpea

Agro-climatic and hydrological characterization of selected watersheds of northern Ghana

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Abstract

This paper provides the climatic and biophysical context of selected watersheds in northern Ghana, Dimbasinia and Zanlerigu in the Upper East region and Binyaahili in the Northern region. The area is subject to changing agricultural practices and climatic change. The objective of the study was to describe the agro-climatic and hydrological features of the watersheds from a landscape perspective. The work builds on primary and secondary data to characterize the watersheds, including historic climate analysis, watershed delineation, soil and land cover mapping and agricultural production systems characterization. Analysis of the climatology shows increasing trends in annual rainfall and potential evapotranspiration (PET) in all three watersheds. The mean annual water inputs (rainfall) to the watersheds were calculated to be 989, 1001 and 1013 mm/yr for Dimbasinia, Zanlerigu and Binyaahili, respectively. The increasing trend in annual rainfall is significant in the Zanlerigu and Bihinaayili watersheds but insignificant in the Dimbasinia watershed. The increasing trend for PET is significant only in the Bihinaayili watershed. Temporally, water surplus occurs about 3 months in a year, with only one month providing significant surplus. Three cropping systems are practiced in Binyaahili and Zanlerigu watersheds, namely, mixed cropping, inter-cropping, and crop rotation, whereas two cropping systems are practiced in the Navrongo watershed, featuring crop rotation and intercropping. Irrigation in the three sites is done between December-June, December-April, and, November-April in Tamale, Zanlerigu and Navrongo, respectively. Annual average well recharge rates are 36, 63 and 60 mm/yr at Bihinaayili, Zanlerigu and Dimbasinia watersheds. The electrical conductivities and soil chemical parameters across the study sites shows that soil salinity is not a problem and the soils suitable for irrigation and crop system intensification, albeit it requires substantial fertilizer inputs. The textural classification suggests that soils in all sites would be ideal for surface irrigation and other pressurized irrigation systems because they do have good textural composition with clay and silt constituents. The water quality data collected 2015-2016 for the three watersheds revealed that the water from wells, reservoirs and rivers is of good quality for irrigation and for domestic purposes. We conclude there appears to be opportunities from both a soil quality and water availability perspective water could to enhance sustainable intensification through small- and medium scale irrigation in the selected catchments.

Key words: climate change, watersheds, dry spell, hydrological characterization, irrigation water requirement

Smallholder irrigation productivity for sustainable intensification: water balances for high value crops in northern Ghana

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Abstract

Sustainable intensification for smallholder farming systems in sub-humid and semiarid zones of West Africa critically hinges not only on agronomy and crop varieties but also the management of on-farm water in rainfed and dry seasons to enhance crop and livestock productivities. IWMI has implemented on-farm trials on the under-researched area of smallholder dry season irrigation as a means to generate food and nutrition security, and income while obtaining the most of the available water resources. On one hand, smallholder opportunities must be realized and operationalized with suitable and functional technologies to attain benefits in yields, income and nutrition. On the other hand, these technologies must work in tune with the environment to attain sustainability when scaled in the watersheds and landscapes.

Here we report that dry spells affect smallholder farmers' rainfed production systems, impacting intensification if water management opportunities are not addressed. We show that additional opportunities in water management can enable dry season irrigation and add towards farmer's sustainable use of land and water resources for income and nutritional benefits. Our analysis is grounded in on-farm field trials with motorized pumps, tanks and drip kits from 2 sites in northern Ghana, within the Savanna Agricultural Development Authority (SADA) growth corridor. We conducted trials on dry season irrigation of vegetables with selected farmers in the Africa Rising project sites, combining water lifting and conveyance and application technologies on high value vegetables, and rainfed maize. Furthermore, we used field data with the CROPWAT model as an example to illustrate how sustainable intensification contributes to sustainable development goal number 6 on water productivity.

The results showed that although average annual rainfall amounts across the northern regions exceeds 1,000 mm/yr, there is a 60-80% chance of a dry spell exceeding 7 days and 30-40% chance of a dry spell exceeding 10 days while longer dry spells of 14 and 21 days do occur but much less frequent. Dry spells ultimately resulting in yield decrease unless water management strategies to increase infiltration is practiced. Shorter dry spells (7 -10 days) can be overcome by infield water harvesting and increasing water holding capacity of the soils, however for longer dry spells (14-21 days) supplementary irrigation is to be considered. In addition, dry season irrigation results in best productivity (kg yield m⁻³ water applied) between 50-75% of crop requirement, resulting in yields, 70-90% of potential yield if well scheduled for typical high value crops such as tomato, onion and pepper. To maximize incomes per unit water in dry season irrigation, farmers need good scheduling advice and devices. This also benefits sustainable intensification. Hence we recommend to assist farmers to improve water management in order to meet objectives of sustainable intensification fully.

Towards a Peanut (*Arachis hypogaea* L) Value Chain for Income and Nutrition without Aflatoxins in Northern Ghana

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Abstract

Peanut is an important cash crop and component of diet, particularly protein source for many rural households in Ghana. Close to 90% of farm families especially in the Guinea savanna zone consider peanut as the most important grain legume. However, aflatoxins contamination remains a major challenge among interventions targeted at upgrading the peanut value chain (PVC). This study concerns about up-grading the PVC with emphasis on aflatoxins management and consumer food safety issues. This study evaluates how the current handling operations influence aflatoxin levels in small-holder storage structures, and determine total aflatoxin levels in peanut sampled from farmer storage units and on-farm research trials. Participatory approaches such as focus group discussions and farmer field schools were included to sensitize actors on good production practices to minimize aflatoxin contamination. Total aflatoxins in farmer stored nuts ranged from 0.0 to 1546 ppb (n=240) at 4 to 8 weeks after harvest (WAH); with wide variations across communities and districts. Using up to 20 ppm permissible level, 92.9% of samples from farmer stored peanuts and 98.7% of samples (n=150) from the participatory on-farm experiments were classified as safe for human use at 4-8 WAH. Thus, sustainable reduction of aflatoxins to safe limits is possible through greater collaboration among actors in the PVC. Low-cost production practices such as improved seed, early weeding, soil fertilization, quick drying, sorting and improved storage, which are within the remit of the PVC actors alongside public awareness programmes should be prioritized.

Key words: On-farm storage, aflatoxin resistance, food safety, awareness, consumers

Household food insecurity, coping strategies and nutritional status of pregnant women in rural areas of Northern Ghana

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Abstract

The International Institute of Tropical Agriculture (IITA) has been collaborating with the University for Development Studies (UDS), Ghana Health Service, Ministry of Food and Agriculture (MoFA) to improve on household food security in the project districts in Northern Ghana. There is however, limited information on the magnitude and determinants of household food insecurity and how it relates to the nutritional status of pregnant women in the project communities.

The magnitude, determinants of household food insecurity (HFI), and how it relates to the nutritional status of pregnant women belonging to different gestational ages were evaluated in the Africa RISING West Africa project intervention communities in Northern Ghana.

A household-based cross-sectional study involving 400 pregnant women in different stages of gestation was conducted in 25 communities. The Household Food Insecurity (HFI) was quantified using the Household Hunger Scale. Mid upper arm circumference (MUAC) was used to assess the nutritional status of the women. Binary logistic regression was performed to test whether HFI significantly predicts maternal nutritional status, controlling for potential confounding factors. A P value of < 0.05 was considered statistically significant.

The mean dietary diversity score (DDS) of study population from ten food groups was 4.2 ± 1.5 (95 % CI: 4.08 to 4.37). Based on the new minimum dietary diversity for women (MDD-W), dietary scores were further classified into low and high diversity. Pregnant women having a diversity score of less than 5 were classified as having low dietary diversity and scores of 5–10 were classified in the high dietary diversity category. Of the 400 women, 46.1 % (95 % CI: 40.0 to 52.2) met the MDD-W.

The average HFIAS Score was 7.2 ± 6.5 and the median household hunger scale (HHS) was 0 and minimum and maximum values being 0 and 6 respectively. Food insecurity was highest in the Kasena-Nankana/Bongo Districts.

Logistic regression analysis showed that households with larger number of children (> 4) under five years were 6 times more likely (AOR=6.85, CI:2.13, 22.05) to be food insecure.

Compared to the Nadowli District, women resident in the Kasena-Nankana/Bongo District were 6 times more likely of experiencing food insecurity (OR=6.91, CI: 3.16, 15.11) and households having lower wealth index (AOR=5.14, CI: 2.88, 9.18) were 5 times more likely to be food insecure.

Significant proportion of women in food insecure households adopted coping strategies to minimize the impact of food insecurity. The strategies included relying on less expensive foods, limiting portion size of meals and reducing numbers of meals eaten in a day.

Though perceived food insecurity was highly prevalent, it was not associated with maternal thinness of pregnant women. The risk of maternal thinness increased as the gestational age increased and this has a great potential of adversely influencing pregnancy outcomes and overall quality of life.

Key words: Food insecurity, Food coping strategies, moderation, Northern Ghana,

Relationship between agricultural biodiversity and dietary diversity of children aged 6-36 months in rural areas of Northern Ghana

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Abstract

Though the relationship between biodiversity and nutrition appears to be evident from a number of studies, more research is needed to better understand in which socio-ecological settings and contexts do biodiversity and nutritional and dietary outcomes relate and which factors mediate the relationship. This paper investigated whether and how biodiversity contributes to diversified diets of children and how economic factors interact with biodiversity to mediate consumption of nutrient dense foods.

This paper is based on data collected in a base-line cross-sectional survey in November 2013. The study population comprised mothers/primary caregivers and their children who were selected using a two-stage cluster sampling procedure. Dietary diversity was derived from a semi-quantitative 24-hour food recall. The number of crop and livestock species produced on a farm was used as the measure of production diversity.

Hierarchical regression analysis was used to identify predictors and test for interactions. Mediation analyses were used to assess whether socioeconomic status of the household mediates the link between agricultural biodiversity and dietary diversity of child's diet.

There was a positive relationship between agricultural biodiversity (variety of animals kept and plants grown for food) and the diversity of child's diet. Older children (24-36 months), high agricultural biodiversity, small household size and households of higher household wealth index were consistent predictors. The strongest predictor was child's age with a standardized beta (β) weight of 0.45, $p < 0.001$. The second highest contributor was production diversity with beta (β) weight of 0.25, $p = 0.002$.

Socioeconomic status of the household did not mediate the link between agricultural biodiversity and dietary diversity of child's diet. Rather, it interacted with agricultural biodiversity on dietary diversity of child. The interaction term was statistically significant [$\beta = -0.16$ (95% CI: -0.21, -0.004, $p = 0.042$)] and this confirms that the relationship between production diversity and dietary diversity scores differs according to the socioeconomic status of the child's household. Children from households of high wealth index had mean dietary diversity score which was 0.06 standard units significantly higher than their counterparts from households of lower wealth index [$\beta = 0.06$ (95% CI: 0.04, 0.51)].

This study provided evidence that increased agricultural biodiversity positively associated with dietary diversity of preschool children but this relationship was moderated by socioeconomic status of the child's household. It is therefore recommended that the Ministry of Agriculture and related organizations should take steps to train/educate rural farmers on agricultural biodiversity especially the poor ones.

Keywords: Agrobiodiversity, dietary diversity, preschool children, socioeconomic status, interaction, Northern Ghana

Magnitude and determinants of child undernutrition in selected intervention communities in southern Mali from Africa Rising project

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Abstract

Children Undernutrition is one of the main public health problems in Mali. It is caused mainly by poor nutrition and care practices among children aged less than 5 years. Identifying the determinants of undernutrition among such children would help public health planners to reshape and redesign new interventions to reduce this health hazard. This study aimed to identify factors associated with undernutrition including stunting and underweight among children aged less than five years in southern Mali.

A community based cross-sectional study was conducted in 480 school age children and their caregivers living in Koutiala district, Mali. Participants were selected using a simple random sampling technique in communities targeted by AFRICA RISING nutrition intervention. Height and weight of children was measured and their parents or care givers were interviewed for factors associated with undernutrition.

The prevalence of stunting, underweight and wasting were 33.4% and 15.8 % and 23.8% for children aged 6-59 months, respectively. Proportion of caregivers and children with low dietary diversity score were 80.83 and 87.92 respectively. Multivariable analyses showed that the most consistent significant risk factors for stunting were being a male child ($P<0.01$), children aged 24-35 months ($P<0.01$), children aged 36-47 months ($P<0.01$), children aged 48-59 months ($P<0.01$), weaning baby too soon due to another pregnancy ($P<0.01$), presence of other siblings age 0-23 months ($P<0.05$). Factors associated with underweight were being a male child ($P<0.001$), children aged 24-35 months ($P<0.01$), children aged 36-47 months ($P<0.05$), children aged 48-59 months ($P<0.01$), not washing hands at key critical moments including before feeding the child ($P<0.05$).

Community-based integrated agriculture, nutrition and health interventions are needed to reduce the occurrence of undernutrition in Southern Mali. These interventions should aim to improve not only food security and nutrition practices within the continuum of care at the household level, but also hygiene and family planning practices.

Keywords: Malnutrition, stunting, underweight.

Evaluation of the effect of fermentation time on the viscosity and energy density of complementary porridges for children under 24 months

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Abstract

In many developing countries, traditional weaning foods are based on local staple foods that are usually cereals such as sorghum, maize, millet. These traditional weaning foods are usually characterized by low energy and nutrient density well below the recommended values for complementary foods. Fermentation is an effective method of food preservation that is capable to lower pH of food products including cereal-based fermented gruels used as infant weaning foods. We hypothesized that fermentation time have an impact on the viscosity and energy density of complementary porridges. Millet, sorghum and maize flours were fermented during 6, 12 and 18 hours. The fermented pastes were dried, stored and used to make porridges. The viscosity and energetic density of the porridges were determined. Non-treated porridges presented higher viscosities compare to the treated ones however the treated porridges had higher energy density ($p<0.05$). Developed complementary flours may help to improve the nutritional status of children under 24 months.

Key words: weaning porridge, fermentation, energy density, viscosity

END.